

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
27 September 2001 (27.09.2001)

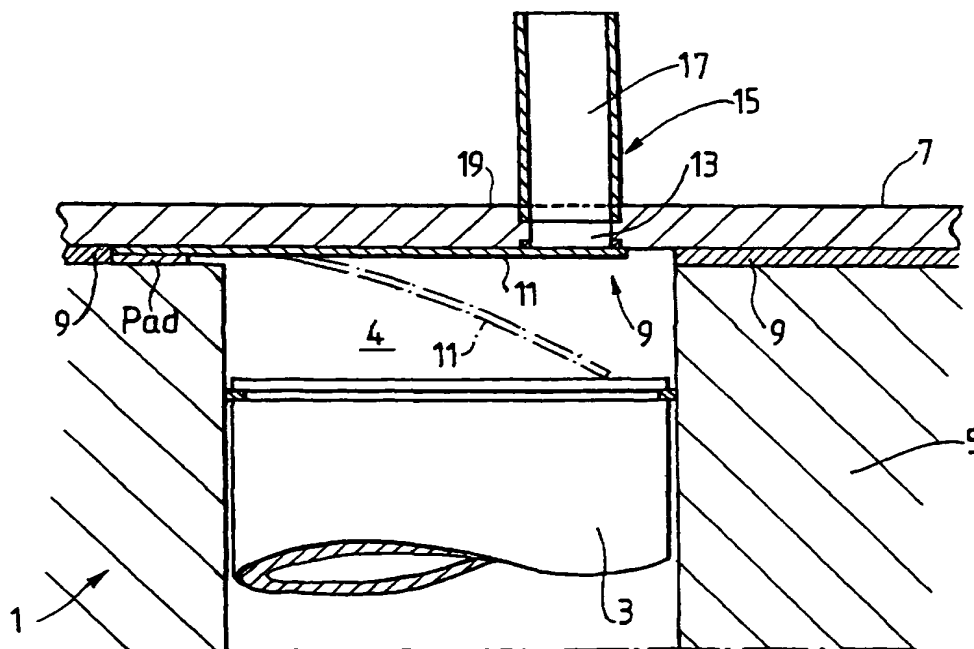
PCT

(10) International Publication Number
WO 01/71189 A1

- (51) International Patent Classification⁷: **F04B 39/10**, 39/00
- (21) International Application Number: PCT/GB01/01240
- (22) International Filing Date: 20 March 2001 (20.03.2001)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
0006978.1 22 March 2000 (22.03.2000) GB
- (71) Applicant (for all designated States except US): **ARCTIC CIRCLE LIMITED** [GB/GB]; Coldnose Court, Coldnose Road, Rotherwas Industrial Estate, Hereford HR2 6JL (GB).
- (72) Inventor; and
- (75) Inventor/Applicant (for US only): **Lawson, Stuart** [GB/GB]; 111 Bath Road, Thatcham, Berkshire RG18 3BH (GB).
- (74) Agent: **JONES, Graham, Henry**; Graham Jones & Company, 77 Beaconsfield Road, Blackheath, London SE3 7LG (GB).
- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
- Published:
— with international search report

[Continued on next page]

(54) Title: A VALVE ASSEMBLY WITH DAMPER MEANS



(57) Abstract: A valve assembly (9) comprising a reed (11), a port (13) which is opened and closed by the reed (11), and damper means (15) for the reed (11), the damper means (15) comprising a tube which is in communication with the port (13) on a side of the port (13) remote from the reed (11), and the tube being of such a size that, in use of the valve assembly (9), the tube contains sufficient fluid to provide substantial damping for the reed (11).

WO 01/71189 A1



— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

A VALVE ASSEMBLY WITH DAMPER MEANS

This invention relates to a valve assembly and, more especially, this invention relates to a valve assembly with damper means.

Valve assemblies comprising a reed and a port which is opened and closed by the reed are well known. Such valve assemblies are often used in compressors or pumps where the reed acts as an automatic valve for controlling the opening and closing of the port. The compressors may be reciprocating compressors for refrigerant vapour in refrigerant apparatus. Known valve assemblies may be such that the port is in a valve plate at the top of a cylinder containing a reciprocating piston. When pressure in the cylinder drops below suction pressure, there is a delay in the valve opening because of factors such for example as the reed sticking to a valve seat around the port. Delays in the opening of the valve result in a significant pressure drop existing across the reed as the valve assembly opens. The effect of this pressure drop is that the reed initially opens much further than its optimum lift and this introduces unnecessary bending stresses in the reed. Furthermore, after the reed has initially opened, it tends to oscillate to and fro. If this oscillation is too vigorous, then it may delay closing of the reed on the port. Prompt closing is usually required, for example in refrigerant apparatus when a piston in a cylinder is at

bottom dead centre and the prompt closing gives better filling of the cylinder with refrigerant.

It is an aim of the present invention to reduce the above mentioned problems.

Accordingly, in one non-limiting embodiment of the present invention there is provided a valve assembly comprising a reed, a port which is opened and closed by the reed, and damper means for the reed, the damper means comprising a tube which is in communication with the port on a side of the port remote from the reed, and the tube being of such a size that, in use of the valve assembly, the tube contains sufficient fluid to provide substantial damping for the reed.

The use of the damping means for the reed avoids unnecessary lift of the reed as it initially opens from the port. This in turn avoids subjecting the reed to unnecessary bending stresses. The use of the damper means also dampens the subsequent oscillations of the reed after it has initially moved away from the port, and the damping of the oscillations helps to ensure that the reed closes promptly on the port. In cases where the valve assembly is used in piston and cylinder refrigerant apparatus, then the valve is able to close promptly when the piston is at bottom dead centre, thereby resulting in better filling of the cylinder with refrigerant.

Usually, the tube will be such that it extends vertically above the port. If desired, the tube may be

positioned away from the port and appropriately connected to the port.

The valve assembly may be one in which the port is in a valve plate, and in which the length of the tube is greater than the diameter of the port. The length of the tube may be at least twice the diameter of the port. Generally, the tube will provide more damping as its length increases. The length of the tube may vary depending upon where the valve assembly is used.

The present invention also provides a compressor or a pump when including the valve assembly of the invention.

An embodiment of the invention will now be described solely by way of example and with reference to the accompanying drawing which is a simplified cross sectional view of a compressor cylinder provided with a valve assembly.

Referring to the drawing, there is shown part of a compressor 1 comprising a piston 3 which reciprocates in a cylinder 4 formed from a cylinder block 5 and a cylinder head comprising a valve plate 7. The valve plate 7 is attached to the cylinder block 5 by means of mounting bolts (not shown) through a gasket 9. The valve plate 7 may be divided by a baffle (not shown) into an inlet side and a discharge side. For simplicity of illustration, the discharge side has not been shown in the drawing.

The inlet side is provided with a valve assembly 9. The valve assembly 9 comprises a reed 11 and a port 13

which is provided in the valve plate 7 and which is opened and closed by the reed 11. The valve assembly 9 also comprises damper means 15 for the reed 11.

The damper means 15 comprises a tube 17 which is in communication with the port 13 on a side 19 of the port 13 remote from the reed 11. The tube 17 is of such a size that, in use of the valve assembly 9, the tube 17 contains sufficient fluid to provide substantial damping for the reed 11.

As can be seen from the drawing, the tube 17 is such that it extends vertically above the port 13. The port 13 is in the valve plate 7 and the tube 17 is of a length which is several times greater than the diameter of the port 13.

When the piston 3 moves downwardly in the cylinder 4 towards its bottom dead centre position, it causes the reed 11 to move away from the port 13 as indicated by the position of the reed 11 shown in broken lines in the drawing. Without the damping means 15, the reed 11 could initially bend too far and thereby become subject to unnecessary bending stresses. After the reed 11 has initially moved away from the port 13, it tends to oscillate backwards and forwards over an area. If the oscillations are excessive, they tend to delay the prompt closing of the valve 11 about the port 13 when the piston 3 reaches bottom dead centre. The damper means 15 is also effective to ensure that the oscillations of the reed 11

are reduced so that the reed 11 is able to close the suction port 13 faster than it would normally do. The dampening of the reed 11 by the damper means 15 ensures that refrigerant is able to flow into the suction side of the valve plate 7 with a much smoother flow than would be the case if the damper means 15 were not employed. The smoother flow is advantageous in that it results in the production of less noise. It is always desirable to reduce on the noise output from compressors used in refrigerant apparatus.

The damper means 15 operates by effectively providing a plug of fluid in the tube 17. For simplicity of explanation, the fluid being pumped by the compressor 1 is considered to be incompressible. At the instant the reed 11 starts to open, there is a significant pressure drop across the reed 11. If the pressure drop were to be maintained while the valve assembly 9 opened, the force on the reed 11 would deflect it well past its equilibrium position as indicated above. The geometry of the valve assembly 9 may act to modify the force acting on the reed 11, but the reed 11 will still overshoot, and then it will cycle about an equilibrium position as mentioned above.

For the force on the reed 11 to be maintained, as the reed 11 opens, the fluid above the reed 11 must move with the reed. In order for the fluid to move with the reed 11, the fluid must accelerate and it will absorb energy. The energy absorbed by the fluid is a function of the velocity

squared and its mass. The more energy that is absorbed by the fluid, the less energy there is for transferral to the reed 11, and thus the maximum deflection of the reed 11 is able to be reduced. The required velocity of the fluid in the tube 17 is a function of the velocity of the reed 11. The tube 17 provides a mass of fluid which moves at the same velocity as the reed 11, and which results in less energy being transferred to the reed 11.

When the reed 11 tries to close, the opposite effect occurs. The reed 11 now has to stop the plug of fluid in the tube 17 which is flowing towards it, thus damping the closing of the reed 11.

By definition, the compressor 1 does not pump incompressible fluids and therefore the detail of the damping as described above is modified but, nevertheless, the damping principle as described above still applies.

By using the damper means 15, the volumetric efficiency of the compressor 1 is able to be improved. The noise generated by the compressor 1 and its associated equipment is able to be reduced. Unwanted failures of the reed 11 are also able to be reduced.

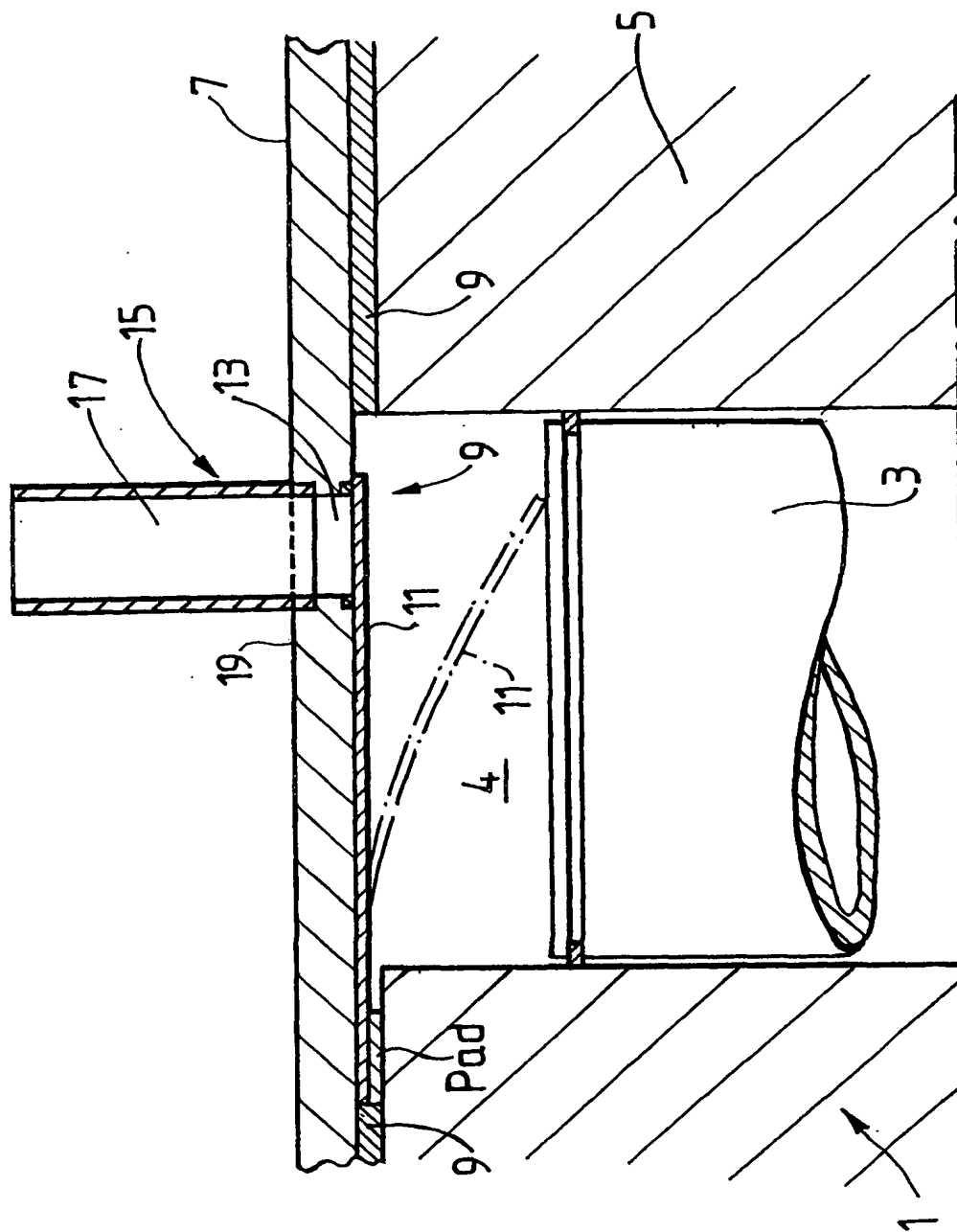
It is to be appreciated that the embodiment of the invention described above with reference to the accompanying drawing has been given by way of example only and that modifications may be effected. Thus, the drawing shows the tube 17 as a simple tube which is of the same diameter as the port 13. If desired, the tube 17 may be of

a different diameter to the port 13. The tube 17 may also be positioned remote from the port 13 and connected directly to the port 13. The tube 17 could be formed as a passage in a cylinder head or in some other means. The reed 11 may be a reed which has a projection which engages with a stop member in the cylinder wall, the stop member limiting movement of the reed to a small degree. Such a reed is disclosed in UK Patent No. 2105821A. The reed may also be an elongate resilient reed of the type disclosed in UK Patent No. 2161583. The reed may still further be a reed with a straight end as disclosed in UK Patent Application No. 9825550.8.

CLAIMS

1. A valve assembly comprising a reed, a port which is opened and closed by the reed, and damper means for the reed, the damper means comprising a tube which is in communication with the port on a side of the port remote from the reed, and the tube being of such a size that, in use of the valve assembly, the tube contains sufficient fluid to provide substantial damping for the reed.
2. A valve assembly according to claim 1 in which the tube is such that it extends vertically above the port.
3. A valve assembly according to claim 1 or claim 2 in which the port is in a valve plate, and in which the length of the tube is greater than the diameter of the port.
4. A valve assembly according to claim 3 in which the length of the tube is at least twice the diameter of the port.
5. A compressor or a pump when including a valve assembly according to any one of the preceding claims.

1/1



INTERNATIONAL SEARCH REPORT

ational Application No
rui/GB 01/01240

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F04B39/10 F04B39/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 275 541 A (BECKER ERICH ET AL) 4 January 1994 (1994-01-04) abstract column 3, line 33 -column 4, line 15 column 5, line 14 -column 7, line 48 figures 1,2	1-5
X	US 5 895 208 A (BECKER ERICH ET AL) 20 April 1999 (1999-04-20) abstract figures 2,5	1-5
X	DE 30 23 928 A (BECKER ERICH) 14 January 1982 (1982-01-14) page 5, paragraph 2 - paragraph 4 page 7, paragraph 1 -page 8, paragraph 1 figures 1,2	1-5
	--- -/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- * & * document member of the same patent family

Date of the actual completion of the international search

12 July 2001

Date of mailing of the international search report

18/07/2001

Name and mailing address of the ISA
European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Kolby, L

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 01/01240

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>US 4 573 881 A (ROMER BENDT W) 4 March 1986 (1986-03-04) abstract column 3, line 15 - line 39 figures 1,2</p> <p>-----</p>	1,3-5

INTERNATIONAL SEARCH REPORT

International Application No

ru/GB 01/01240

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5275541	A	04-01-1994	DE 4200838 A FR 2687738 A GB 2263319 A,B JP 3083666 B JP 6272665 A	22-07-1993 27-08-1993 21-07-1993 04-09-2000 27-09-1994
US 5895208	A	20-04-1999	DE 19639555 C FR 2753750 A GB 2317655 A,B JP 2933895 B JP 10103244 A	20-11-1997 27-03-1998 01-04-1998 16-08-1999 21-04-1998
DE 3023928	A	14-01-1982	JP 57037161 A	01-03-1982
US 4573881	A	04-03-1986	DE 3332259 A BR 8404433 A CA 1264466 A DK 411684 A,B, JP 60073071 A SE 460374 B SE 8404306 A	28-03-1985 30-07-1985 16-01-1990 08-03-1985 25-04-1985 02-10-1989 08-03-1985

TENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference Jg-2573-PCT	FOR FURTHER ACTION <small>see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.</small>	
International application No. PCT/GB 01/ 01240	International filing date (day/month/year) 20/03/2001	(Earliest) Priority Date (day/month/year) 22/03/2000
Applicant ARCTIC CIRCLE LIMITED et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.



It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.



the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :



contained in the international application in written form.



filed together with the international application in computer readable form.



furnished subsequently to this Authority in written form.



furnished subsequently to this Authority in computer readable form.



the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.



the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,



the text is approved as submitted by the applicant.



the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,



the text is approved as submitted by the applicant.



the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.



as suggested by the applicant.



because the applicant failed to suggest a figure.



because this figure better characterizes the invention.

1



None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/GB 01/01240

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 7 F04B39/10 F04B39/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 275 541 A (BECKER ERICH ET AL) 4 January 1994 (1994-01-04) abstract column 3, line 33 -column 4, line 15 column 5, line 14 -column 7, line 48 figures 1,2 ---	1-5
X	US 5 895 208 A (BECKER ERICH ET AL) 20 April 1999 (1999-04-20) abstract figures 2,5 ---	1-5
X	DE 30 23 928 A (BECKER ERICH) 14 January 1982 (1982-01-14) page 5, paragraph 2 - paragraph 4 page 7, paragraph 1 -page 8, paragraph 1 figures 1,2 --- -/--	1-5

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

G document member of the same patent family

Date of the actual completion of the international search

12 July 2001

Date of mailing of the international search report

18/07/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
 Fax: (+31-70) 340-3016

Authorized officer

Kolby, L

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 01/01240

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>US 4 573 881 A (ROMER BENDT W) 4 March 1986 (1986-03-04) abstract column 3, line 15 - line 39 figures 1,2 -----</p>	1,3-5

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB 01/01240

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5275541	A	04-01-1994	DE 4200838 A	22-07-1993
			FR 2687738 A	27-08-1993
			GB 2263319 A,B	21-07-1993
			JP 3083666 B	04-09-2000
			JP 6272665 A	27-09-1994
US 5895208	A	20-04-1999	DE 19639555 C	20-11-1997
			FR 2753750 A	27-03-1998
			GB 2317655 A,B	01-04-1998
			JP 2933895 B	16-08-1999
			JP 10103244 A	21-04-1998
DE 3023928	A	14-01-1982	JP 57037161 A	01-03-1982
US 4573881	A	04-03-1986	DE 3332259 A	28-03-1985
			BR 8404433 A	30-07-1985
			CA 1264466 A	16-01-1990
			DK 411684 A,B,	08-03-1985
			JP 60073071 A	25-04-1985
			SE 460374 B	02-10-1989
			SE 8404306 A	08-03-1985